

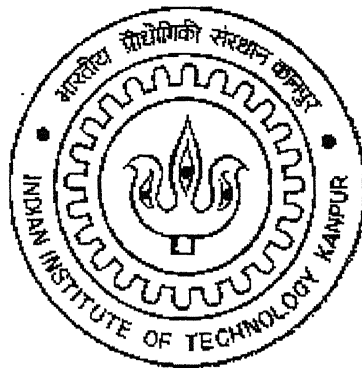
SUPPLIER INVOLVEMENT AT VARIOUS STAGES OF NEW PRODUCT DEVELOPMENT

A Thesis submitted
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF TECHNOLOGY

by

HARI PRASAD AMBADAPUDI



**Department of Industrial and Management Engineering
INDIAN INSTITUTE OF TECHNOLOGY, KANPUR
April, 2003**

CERTIFICATE



This is to certify that the work contained in the Thesis titled “**Supplier involvement at various stages of New Product Development**” has been carried out by **Hari Prasad Ambadapudi** under my supervision and that his work has not been submitted elsewhere for a degree.

A handwritten signature in dark ink, appearing to be "A.P. Sinha", written in a cursive style.

April, 2003

Dr. A. P. Sinha,
Professor,
Dept of Industrial and Management Engineering,
Indian Institute of Technology,
Kanpur-208016.

2 - AUG 2003

बुधोत्तम काशीनाथ केजकर पुस्तकालय
भारतीय प्रौद्योगिकी संस्थान, कानपुर
अवधि क्र० A.....144417.....



A144417

ABSTRACT

This study investigates into the effects of various determinant variables which affect supplier-involvement at different stages of the New Product Development process. Suitable research hypotheses were formulated to explain the influence of the determinant variables. Automobile and white goods sectors were targeted to get the responses from, as they both are dominant new product introducers. A personal survey method with a questionnaire is chosen as suitable method for the data collection. Responses are sought from materials, purchasing and supply chain departments of the firms. Statistical analysis is carried out on the obtained data and significant results are reported. Effects of the determinant variables on the supplier involvement at various stages of the NPD process is explained.

ACKNOWLEDGEMENTS

I take this opportunity to express my deep sense of gratitude and profound indebtedness to my Thesis supervisor Dr. Arun. P. Sinha for his constant support and invaluable suggestions which had helped me in completing my Thesis work successfully.

My stay at IITK was unforgettable to say the least, and the biggest reason for it being my classmates of the M.Tech 2001 batch. I express my thanks to the entire IME Faculty and Staff for providing an atmosphere that made the learning a wonderful experience.

My special thanks to Ramakrishna, Ramgopal Prajapat Vinay Gupta and Niket for the nice company they have provided.

I would like to thank my parents for bringing me to this stage of life. It were their blessings which always gave me courage to face all challenges and made my path easier.

HARI PRASAD AMBADAPUDI

*“Dedicated to the Golden
Feet of Lord Sai Baba”*

CONTENTS

CERTIFICATE

ABSTRACT

ACKNOWLEDGEMENTS

LIST OF EXHIBITS

| | Page No |
|--|---------|
| 1. Introduction | |
| 1.1 Introduction | 1 |
| 1.2 Scope of the study | 2 |
| 1.3 Thesis organization | 3 |
| 2. Literature Review | |
| 2.1 New Products | 4 |
| 2.2 New Product Development stages | 5 |
| 2.2.1 Idea Generation | 5 |
| 2.2.2 Idea Screening | 5 |
| 2.2.3 Concept Development and Testing | 6 |
| 2.2.4 Marketing Strategy Development | 6 |
| 2.2.5 Business Analysis | 6 |
| 2.2.6 Product Development | 7 |
| 2.2.7 Market Testing | 7 |
| 2.2.8 Commercialization | 7 |
| 2.3 Supplier involvement in new product developments | 8 |
| 2.3.1 Advantages of supplier involvement | 8 |
| 2.4 Helper's Model for Buyer-Supplier relations | 9 |
| 2.5 Portfolios of Buyer-Supplier relationships. | 11 |
| 2.6 Roles and responsibilities of suppliers in new product Developments | 13 |
| 2.7 Summary of Literature Study | 15 |
| 3. Hypothesis Development | 16 |
| 3.1 Product complexity. | 17 |
| 3.2 Time pressure. | 18 |

| | |
|--|----|
| 3.3 Cost pressure. | 19 |
| 3.4 Degree of specialization. | 19 |
| 3.5 Co-location of supplier firm. | 20 |
| 3.6 Trust. | 21 |
| 3.7 Information Technology | 22 |
| 3.8 Informal source of market information. | 23 |
| 3.9 Time gap between new products. | 24 |
| 4. Methodology | |
| 4.1 Study Methodology | 25 |
| 4.2 Details of the questionnaire | 25 |
| 4.2.1 Questionnaire description. | 26 |
| 4.2.2 Scale used for study. | 27 |
| 4.2.3 Software used for statistical analysis. | 27 |
| 5. Results and Discussion | |
| 5.1 Different levels of supplier involvement. | 28 |
| 5.2 Testing of Hypotheses. | 29 |
| 5.3 Key determinant variables. | 30 |
| 5.3.1 Supplier influence on Idea screening stage. | 33 |
| 5.3.2 Supplier influence on concept testing stage. | 34 |
| 5.3.3 Supplier influence on market testing stage. | 34 |
| 5.4 Supplier influence on the commercialization stage. | 34 |
| 5.5 Supplier influence on the Idea generation stage. | 35 |
| 6. Conclusions and Limitations. | |
| 6.1 Conclusions. | 37 |
| 6.2 Limitations of the present study. | 39 |

REFERENCES

Appendix-A

LIST OF EXHIBITS

| Exhibit Number | Description | Page No |
|----------------|--|---------|
| 2.1 | Comparison of American and Japanese Buyer-Supplier relations. | 10 |
| 2.2 | Types of Buyer-Supplier relations. | 11 |
| 2.3 | Four supplier roles. | 14 |
| 5.1 | Different levels of supplier involvement at different stages | 29 |
| 5.2 | Contingency table for Time Pressure and Idea Screening | 30 |
| 5.3 | What affects the supplier involvement in the NPD process | 31 |
| 6.1 | Effect of various determinant variables on The supplier involvement during new product Development process | 38 |

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

New products are central to the growth and prosperity of the modern enterprise. In order to provide value and win customers, companies must quickly and accurately identify changing customer needs and wants, developing more complex products to satisfy those needs, providing higher levels of customer support and service. At the same time in order to fulfill the customer needs, the enterprise has to try and provide greater functionality, performance and reliability. Consequently, new product development (NPD) has always been, and is increasingly more, a central mechanism through which a company's strategy can be put into practice.

New product development has been identified as a core process that is instrumental for success in the new global economy. Some of the benefits that accrue to organizations that can master the creative processes required in bringing new products to market include speed, improved quality, lower cost, improved market share, competitive advantage, and greater intellectual capital.

An array of different variables deemed critical to successful new product development are Product effectiveness ,Market issues ,Project leadership, senior management support ,Team composition, organizational structure and processes and Supplier integration

Apart from other variables that affect New Product developments, supplier integration assumes great importance. Suppliers have a large and direct impact on cost, quality, technology, speed, and responsiveness of buying companies. Effective integration of suppliers into the product value/ supply chain will be a key factor in achieving the improvements necessary to remain competitive.

Supplier integration involves a large number of variables that lead to success. Issues that arise with regard to supplier integration include tier structure, degree of responsibility for design, specific responsibilities in the requirement setting process, when to involve suppliers in the process, inter-company communication, and supplier membership on the project team.

1.2 SCOPE OF THE STUDY

This study is mainly concerned with supplier involvement in the buyer's processes of bringing out new products. Companies, both from the automobile sector and white goods sector, are chosen for analysis as both sectors are dominant new product launchers in the market.

In this study more emphasis is given on the understanding of various stages of new product developments and the various levels of supplier integration into them that affects the buyer-supplier relations.

During the process of integration of the supplier capabilities with the buyer in bringing the new products, lot of inter and intra organizational activities take place as the organizations are mutually dependent on each other.

In this study, information about six organizations was gathered. They include both the two wheeler and four wheeler segments of the automobile market, and two firms from the white goods sector.

1.3 THESIS ORGANIZATION

This study is broadly divided into six chapters. The first chapter gives an overview of the importance of the new products to organizations. It also emphasizes the importance of timely involvement of suppliers in the process of developing new products.

Second chapter reviews the literature and describes the various stages in the new product developments in detail. Concurrent Engineering is also discussed along with its advantages and systems approach. The concurrent engineering practices in the new product development are also tabulated.

Third chapter outlines the research hypotheses that are formulated based on the literature review.

Fourth chapter introduces the methodology adopted for the study. This chapter also speaks about the description of the questionnaire that is used to get the responses and the software that is used to tackle the data analysis part.

Fifth and sixth chapters narrate the results of the hypothesis testing, and conclusions and limitations of the thesis respectively

CHAPTER 2

LITERATURE REVIEW

2.1 NEW PRODUCTS

New products are important for any enterprise. Sometimes, a new product is so novel that it creates an entirely new market. At other times, the new product may be less remarkable. There can in all six categories of new products.

- New products that create an entirely new market.
- New product that allows a company to enter an established market for the first time.
- New products that supplement a company's established product lines.
- New products that provide improved performance or greater perceived value by replacing existing products.(usually known as "New Model")
- Existing products that are targeted to new markets or market segments.
- New products that provide similar performance at lower cost.(usually known as "New Model") [4]

2.2 NEW PRODUCT DEVELOPMENT STAGES

Broadly, the new product development process consists of the following stages

- Idea Generation.
- Idea screening.
- Concept development and testing.
- Marketing strategy development.
- Business Analysis.
- Product development.
- Market testing.
- Commercialization.

2.2.1 Idea Generation

The new product development starts with the search for ideas. New product ideas can come from various sources such as customers, suppliers, competitors, employees, and top management. The marketing concept says that *customer needs and wants are the logical place to start the search for ideas*. Although ideas flow from many sources, they receive serious attention only if they get approved by a product champion. [4]

2.2.2 Idea Screening

In the idea screening stage, each idea is evaluated. The purpose of screening is to drop poor ideas as early as possible. Otherwise, the product-development costs rise substantially with each successive development stage.

2.2.3 Concept Development and Testing

2.2.3.1 *Concept Development*

Before translating a product idea into a concept, some basic information about the users of the product to be developed and the benefits that the product is going to deliver when compared with the existing product must be sought.

2.2.3.2 *Concept Testing*

Concept testing involves presenting the product concept to appropriate target consumers and getting their reactions. However, the more the tested concepts resemble the final product or experience, the more dependable concept testing is.

2.2.4 Marketing Strategy Development

After concept testing, the new product manager develops a preliminary marketing-strategy plan for introducing the new product into the market. The plan would consist of many aspects like target market's size, structure, and behaviour; the planned product positioning; and the sales, market share, and profit goals sought in the first few years.

2.2.5 Business Analysis

After management develops the product concept and marketing strategy, it can evaluate the proposal's business attractiveness. Management needs to prepare sales, cost, and profit projections to determine whether they satisfy company objectives. If they do, the product concept can move to the product development stage.

2.2.6 Product Development

If the product concept gets approved in the business analysis stage, it moves to R&D or Engineering for physical product development. This step involves a steep rise in investment compared to the costs incurred in the earlier stages.

The R&D department will develop one or more physical versions of the product concept. Its goal is to find a prototype that performs safely under normal use and conditions, and that can be produced within the budgeted manufacturing costs.

2.2.7 Market Testing

Once the product's functional and structural requirements are approved by the management, the product is ready to be put to a market test. The new product is introduced to learn how large the market is and how customers and dealers react.

2.2.8 Commercialization

Commercialization is a full scale release of the product into the market keeping in view the target customers, target market segment. In commercializing a new product, market-entry timing is critical. Every company has three choices in this respect. In the first entry type of situation, the first firm entering a market usually enjoys the "first mover advantages". But, if the product is rushed to market before it is thoroughly debugged, the product can acquire a flawed image. In a parallel entry type of situation, the firm might time its entry to coincide with the competitor's entry. In the late entry type of situation, the firm might delay its launch until the competitor has entered. The competitor will have borne the cost of

educating the market. The competitor's product may reveal faults the late entrant can avoid. The company can also learn the size of the market.

2.3 SUPPLIER INVOLVEMENT IN NEW PRODUCT DEVELOPMENTS

Supplier involvement in new product development can be beneficial with regard to the costs and quality of new products. Consequently, more and more suppliers are becoming involved in development projects. This involvement may range from giving minor design suggestions (e.g. to improve a component's manufacturability) to being responsible for the complete development of a specific part or sub-assembly.

2.3.1 Advantages of early supplier involvement

According to the article by Infuse. Inc [12] if the suppliers are involved at an early stage of the product development, they become aware of the details of the new products. Early involvement of supplier also helps in selection of several standard components for which a supplier already has manufacturing capabilities. This, in turn, reduces the cost. Early involvement also leads to early identification of alternative technical proposals.

Early involvement of suppliers helps in wider exploration before final specifications are issued. Suppliers are able to match their capabilities with the manufacturing requirements of the product; in other words, the design becomes more manufacturable. There will be fewer engineering changes. Better quality is achieved as designers have a better idea of the suppliers' capabilities. Early involvement of the suppliers also gives them sufficient time to refine their processes.

Early involvement of suppliers leads to early identification of technical problems. It also gives suppliers time to acquire capabilities necessary for the product. This reduces time to market

2.4 HELPER'S MODEL FOR BUYER SUPPLIER RELATIONS

Helper [5] after examining the buyer supplier relations in America and Japan lists down two alternative models of buyer supplier relations for the automotive industry, the exit model and the voice model. He compared several factors to explain the differences in the buyer supplier relations in the two scenarios.

US exit model is characterized with a low information exchange, where as lot of information is exchanged between buyer and supplier in the Japanese model. Information flow is one way in the US "exit" model. Coming to the commitment between buyers and suppliers, a low commitment is seen in the case of US buyers and suppliers, where as high commitment is observed in the Japanese case.

The amount of trust placed by the American buyers in their suppliers is also low when compared with their Japanese counterparts. The length of the relationship between the buyers and suppliers in US is low when compared with Japan.

The competition between the suppliers is purely price based in US model where as it is based on several factors like quality, delivery lead times and cost in the Japanese model.

| Factors for comparison | US "Exit" Model | Japan "Voice" Model |
|------------------------|---|---|
| Information Exchange | Low | High |
| Commitment | Low | High |
| Relationship | Adversarial | Close |
| Sourcing | More sole sourcing | Numerous suppliers |
| Length of relationship | Switch suppliers with ease | Long-term relationships |
| Basis for competition | Solely price based | Based on quality, delivery, Engineering and price |
| Culture | Search for new suppliers if problems arises | Work with existing suppliers to resolve problems |

Exhibit 2.1 Comparison of American and Japanese Buyer Supplier relations [5]

Helper states that American automotive buyer supplier relations have traditionally been characterized by the "exit" model, whereas the "voice" model is more typical of Japan. In essence, when faced with problems, American buyers *exit* existing relationships to find other suppliers, whereas Japanese firms *voice* concerns and deal with them within existing relationships.

2.5 PORTFOLIOS OF BUYER-SUPPLIER RELATIONSHIPS

Relationship between buyer and supplier can also be understood on the basis of mutual dependency or the lack of it. Bensaou [9] has conceptualized a matrix of possibilities based on how much each party invests specific to that supply relation.

Based on the specific investments both from the buyer's and the supplier's side, the relationships are classified into four types, as shown in exhibit 2.2

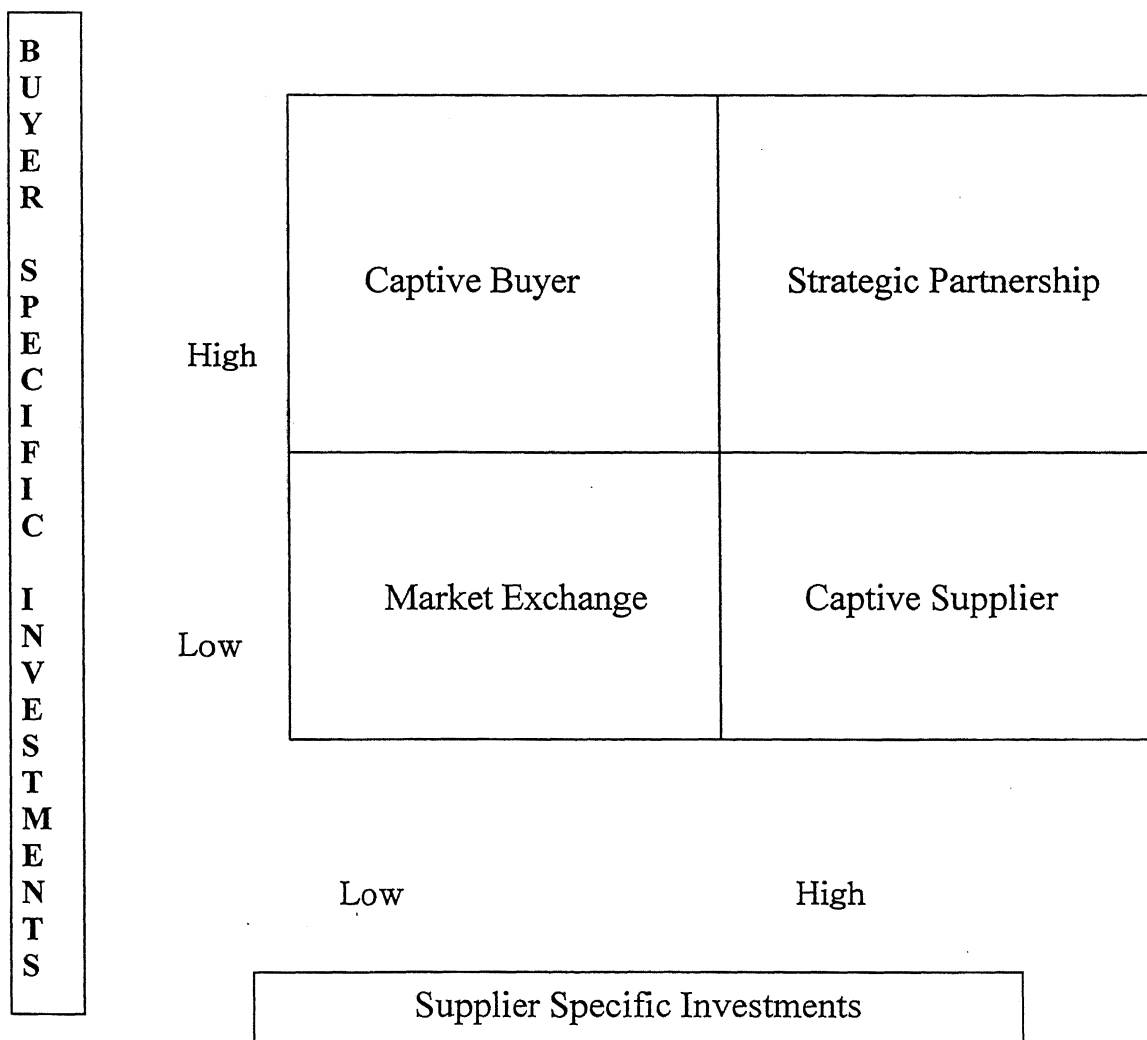


Exhibit 2.2 Types of buyer supplier relations [9]

In the above figure, the vertical axis represents buyer's specific investments. These are tangible investments in buildings, tooling and equipments. Buyer's investments also include intangible investments like spending time and effort in understanding supplier's business processes. The horizontal axis represents supplier specific investments. Tangible supplier investments include plant or warehouse layout and specialized facilities and dies.

Based on the specific investments by both the buyer and the supplier, their relationships are broadly categorized in four types.

Captive Buyer: The captive buyer situation refers to that situation where in buyer invests a lot in the assets. The investment from the supplier side is low and the supplier is free to switch to other buyers easily.

Captive Supplier: This is the reverse of the captive buyer situation. Here the supplier invests a lot in the assets. The investment from the buyer side is low and the buyer is free to switch to other suppliers easily.

Strategic partnership: This relation forms out of the greater trust both the firms enjoy. The specific investments from both the parties are considerably high.

Market exchange: The market exchange situation represents the cluster of relationships in which neither of the parties has developed specialized assets to work with each other; they can work together using generalized assets. Each party can turn to market place and shift to another business partner at low cost and minimal damage. [9]

2.6 ROLES AND RESPONSIBILITIES OF SUPPLIERS IN NEW PRODUCT DEVELOPMENTS

In a some what different approach, Kamath and Liker [10] have analyzed the supplier buyer relation in terms of mutual responsibilities and maturity. According to them the role of supplier can be viewed as one of the four types as shown in exhibit 2.3.

In the Japanese tier structure, which simplifies the communication between customers and suppliers, the first tier suppliers co-ordinate the activities of the second tier and so on down the hierarchy. Thus the first tier may function as a partner while the lower tiers may be purely contractual.

The role of supplier in the NPD process varies according to the situation. In a purely contractual situation, the supplier would take the responsibility for nothing more than proper and quality delivery. On the other hand in a full system supply situation, the supplier takes major responsibility, develops system on its own and even suggest alternatives to the buyer.

In a child type of supply situation, the supplier is given responsibility to manufacture simple assemblies. The supplier manufactures the products according to the design specifications of the buyer. On the other hand in a partner type of situation, the supplier takes greater share of responsibility supplier is given the responsibility of entire sub systems. In this type of situation, supplier is involved from the pre concept stage.

| Role | Description | Responsibilities during product development |
|---------------------------------|---|--|
| Partner (Full-Service Provider) | Relationship between equals; supplier has technology, size and global reach. | Entire Sub system. Supplier acts as an arm of the buyer and participates from the pre concept stage onwards. |
| Mature(Full-system supplier) | Buyer has superior position; supplier takes major responsibility with close customer guidance | Complex assembly. Buyer provides specification, then supplier develops system on its own. Supplier may suggest alternatives to the buyer |
| Child | Customer calls the shots, and the supplier responds to meet the demands. | Simple assembly. Customer specifies design requirements, and supplier executes them. |
| Contractual | Supplier is used as an extension of buyer's manufacturing capability. | Commodity or a standard part. Customer gives detailed blue prints or orders from a catalog, and supplier builds. |

Exhibit 2.3 Four supplier roles [10]

2.7 SUMMARY OF THE LITERATURE STUDY

The above literature study has conceptualized in various ways, the relationship between supplier and buyer. These are sometimes in terms of how early in NPD the suppliers are involved. It is alternatively in terms of adversarial relationship in US versus close relationship in Japan. Another study views in terms of the level of dependencies based on how much specific investments are made by buyers and suppliers. And there is also a study that views the relationship in terms of the extent of mutual responsibilities and maturity.

One key aspect of all these reviews is that: suppliers do affect the NPD process. It is however unclear whether the effect is uniform or whether it varies according to the type of new product, the pressures of time and cost, etc and whether it varies during the different stages of the process.

CHAPTER 3

HYPOTHESIS DEVELOPMENT

As discussed in the last chapter, literature has studied in a number of ways, the relationship between supplier and buyer. These include

- How early in NPD the suppliers are involved.
- The adversarial relationship in US versus close relationship in Japan.
- The level of dependencies based on how much specific investments are made by buyers and suppliers, and
- A study that views the relationship in terms of mutual responsibilities and maturity

Though suppliers do affect the NPD process, it is unclear whether the effect is uniform or whether it varies according to the type of new product, the pressures of time and cost, etc and whether it varies during the different stages of the process.

Out of the total eight stages of the new product development process described in the literature, two stages, marketing strategy development and business analysis deal primarily with the business part of the buyer firm and supplier involvement would rarely be seen in them. Remaining six stages are expected to have supplier involvement to various degrees.

The present thesis is focused on precisely these above issues. In the following sections, each relevant factor is analyzed and its likely effect on supplier involvement is discussed. This leads to a set of hypotheses for the study.

3.1 Product Complexity

Customer needs are ever growing. To capture those needs, high sophistication in the product features is essential. Advanced technology is incorporated in the new products that enter the market with the aim of capturing those needs of the customer. As a result the complexity of the product is ever increasing.

As the complexity in the product increases, the skill required to manufacture it increases. More complex setups are required for manufacturing which require more time and more skilled personnel. More number of specialists is to be employed to perform this task. The time required to develop these kinds of products also increases. Supplier involvement under these conditions will be advantageous in bringing the development time down and sharing the costs expended on the specialists there by reducing the overall cost of the product.

The complexity of a product in our present study is expressed as

- Level of complexity in the product
- Number of sub parts/ products that go into the final product
- Engineering intensity that is demanded by the new product
- Requirement of specialized fields for the new products.

These four facets of complexity would require greater degree of involvement of suppliers. This proposition is formalized in the following hypothesis H1 and its subsets.

3.1 Product Complexity

Customer needs are ever growing. To capture those needs, high sophistication in the product features is essential. Advanced technology is incorporated in the new products that enter the market with the aim of capturing those needs of the customer. As a result the complexity of the product is ever increasing.

As the complexity in the product increases, the skill required to manufacture it increases. More complex setups are required for manufacturing which require more time and more skilled personnel. More number of specialists is to be employed to perform this task. The time required to develop these kinds of products also increases. Supplier involvement under these conditions will be advantageous in bringing the development time down and sharing the costs expended on the specialists there by reducing the overall cost of the product.

The complexity of a product in our present study is expressed as

- Level of complexity in the product
- Number of sub parts/ products that go into the final product
- Engineering intensity that is demanded by the new product
- Requirement of specialized fields for the new products.

These four facets of complexity would require greater degree of involvement of suppliers. This proposition is formalized in the following hypothesis H1 and its subsets.

H 1: *If the complexity of the product is higher, the influence of the vendor on the New Product Development process of the buyer will be higher.*

This hypothesis which speaks about the complexity of a product is further expressed as four sub hypotheses.

H 1a: *If the level of complexity of the new product is higher, the influence of the vendor on the New Product Development process of the buyer will be higher.*

H 1b: *If the number of sub parts/ products that go into the new product is higher, the influence of the vendor on the New Product Development process of the buyer will be higher.*

H 1c: *If the engineering intensity demanded by the new product is higher, the influence of the vendor on the New Product Development process of the buyer will be higher.*

H 1d: *If the requirement of specialized fields in the new product is higher, the influence of the vendor on the New Product Development process of the buyer will be higher.*

3.2 TIME PRESSURE

Organizations try to develop the new products quickly in order to gain competitive edge. When the time pressure on the NPD process is high, it becomes necessary that vendors also speed up. To do this the buyer needs to maintain close relationship with the vendors whose opinions about the product become crucial to the process. Thus, simultaneous development of parts takes place and the over all time required for development of the product decreases. This leads to H2.

H 2: *If the time pressure for developing the product is high, the influence of the vendor on the New Product Development process of the buyer will be high.*

3.3 COST PRESSURE

In a similar vein, the complexity and the technology involved in making the new products are also significantly costly for the OEMs to achieve specialty in every field of the product development process. To reduce the cost, buyers assign suppliers with a substantial part of the product development process, and the influence of the supplier in the NPD process is correspondingly high. This leads to H3.

H 3: *If the cost pressure for developing the product is high, the influence of the vendor on the New Product Development process of the buyer will be high.*

3.4 DEGREE OF SPECIALIZATION

To make the product excellent on all fronts, expert makers of the products are to be employed. This often requires specialized services from vendors. When the NPD requires such specialized services, the influence of the vendor on NPD is naturally greater. That is,

H4: *As the degree of specialization of the supplier increases, the Vendor's influence on the New Product Development Process of the buyer firm also increases.*

3.5 CO-LOCATION OF THE SUPPLIER FIRM

If the distance of the supplier firm from the buyer increases, the detection of deviation from the project's expectation decreases. Geographical proximity provides the companies with special access, closer relations and better information.

The co-location of the supplier firm in our present study is expressed in terms of geographical distance of the supplier firm and level of concentration of the suppliers near the buyer firm.

Suppliers which are geographically close to the buyer firm will definitely have a greater coordination and cooperation when compared with the suppliers, which are far distant from the buyer. The supplier firms that are geographically close will have a greater influence in getting the new product quickly to the market. This leads to H4.

H5: The less the distance between the supplier firm and the buyer firm, the more the influence of the vendor on the New Product Development process of the buyer will be.

Similar effects of the co-location of supplier is further expressed as following hypothesis

H5a: The more the concentration of the key supplier firms and the buyer firm in the same geographical region, the more the influence of the vendors on the new product development process of the buyer will be.

3.6 TRUST

Buyers rely on those suppliers who can deliver the goods in time and with the required quality level. The buyer prefers to maintain a long term relation with such suppliers. The buyer will be assured of the quality of supplies from that supplier and the time required for internal quality tests and the cost required for maintaining inventories can be minimized. Such suppliers, that are those whom the buyer trusts, would be the ones who have an influence on the NPD process, that is:

H6: As the trust between the buyer and supplier increases the influence of the vendor on the New Product Development process of the buyer also increases.

The trust between the buyers and suppliers firm in our present study is expressed in terms of length of the relationship between the buyer firm and the supplier firm, amount of informal interaction between their executives, reliability of the supplier firm in terms of lead times and quality of supplies. This leads to the following sub hypotheses.

H6a: As the length of the relationship between the buyer and supplier increases the influence of the vendor on the New Product Development process of the buyer also increases.

H6b: As the amount of informal interaction between the buyer and supplier firms' executives increases, the influence of the vendor on the New Product Development process of the buyer also increases.

H6c: *As the reliability in terms of lead times by the supplier increases, the influence of the vendor on the New Product Development process of the buyer also increases.*

H6d: *As the reliability in terms of quality of supplies by the supplier increases, the influence of the vendor on the New Product Development process of the buyer also increases.*

3.7 INFORMATION TECHNOLOGY

New product development process consists of multiple activities such as idea generation, idea screening, concept testing and development, product development, market testing and commercialization. It also necessitates knowledge creation and sharing. The success of a new product depends on the successful implementation of these activities. One way of facilitating the implementation of these activities is to use information technology (IT).

Use of IT in the new product development activities not only increases the speed but also improves the quality of the NPD process. The usage of IT by both buyers and suppliers is mutually advantageous. Lot of information can be shared between them if both parties use IT. As a result of this sharing through IT, the buyer is able to influence the vendor in many ways. It is interesting to note that, due to symmetry, the vendor is also able to influence the buyer's process of NPD.

H7: *If the supplier firm uses IT facility in the NPD activities, the influence of the vendor on the New Product Development process of the buyer firm increases.*

The IT facilities near the suppliers firm in our present study are expressed in terms of use of IT for product designing activities by the supplier firms; use of IT facilities for information sharing and communication; and use of IT facilities for MRP/ERP packages.

Thus the hypothesis which speaks about the IT facilities at the supplier firm can be further expressed as three sub hypotheses

H7a: If the supplier firm uses the IT facility for product designing activities, the influence of the vendor on the New Product Development process of the buyer firm increases.

H7b: If the supplier firm uses the IT facility for communication and information sharing activities, the influence of the vendor on the New Product Development process of the buyer firm increases.

H7c: If the supplier firm uses the IT facility for MRP/ERP packages, the influence of the vendor on the New Product Development process of the buyer firm increases.

3.8 INFORMAL SOURCE OF MARKET INFORMATION

At times, there are some suppliers which are big in size when compared to the buyers. The supplier firm may also have resources for carrying out the informal market research activities. This way supplier firm can act as an informal source of market information. That is,

H8: If the size of the supplier firm is large when compared to the buyer firm, the possibility of the supplier firm to become an informal source of market information to the buyer firm increases.

3.9 HIGH DEGREE OF NOVELTY

As the firm intends to produce completely new products the need for involvement of expert suppliers for various sub parts of the end product is a must. Specific expertise is desirable in that particular case. As the degree of novelty of the product increases, the involvement of various experts increases. That is,

H9: The influence of the vendor on the New Product Development process of the buyer firm increases as the novelty increases.

CHAPTER 4

METHODOLOGY

4.1 STUDY METHODOLOGY

The basic objective of scientific research is to give logical explanation of a phenomenon. According to the literature, various methodologies that can be applied to a research problem are (1) Case study analysis (2) Secondary data analysis (3) Questionnaire survey and personal interviews.

To understand the various levels of supplier involvement at different stages of a new product development, questionnaire survey methodology has been felt appropriate. The questionnaire survey methodology permits to get the responses from a number of firms operating in different sectors targeting different segments of the market. Firms from both automobile and white goods sector are considered as two sectors currently dominate in bringing new products in India. A comprehensive idea regarding the various levels of the supplier involvement can be sought from the experience in these sectors.

4.2 DETAILS OF THE QUESTIONNAIRE

Nine hypotheses were developed according to the Literature Study. Based on the research hypotheses developed, a questionnaire is designed (Appendix-A) containing 24 questions which tries to explore level of supplier involvement at various stages. Responses for the questionnaire are sought from the people belonging to Purchasing, Materials, Vendor Development and Supply chain departments.

4.2.1 Questionnaire Description

Nine research hypotheses were transformed into appropriate questions for understanding the current levels of involvement of suppliers at various stages.

The first hypothesis which speaks about the complexity of the new product development (NPD) is further operationalised through four measurable metrics: level of complexity involved in the new product, number of sub parts that go into the final new product, level of Engineering intensity required in the new product, and requirement of specialized fields in developing the product.

The fifth and sixth questions represent the second and third hypotheses that are related to the time pressure and cost pressure involved in bringing the new products.

The hypothesis relating to the co-location of the supplier firm is represented by geographical distance of the supplier firm and level of concentration of the suppliers near the buyer firm.

The hypothesis relating to the trust is again operationalised through four aspects: the length of the past relationship between buyers and suppliers, amount of informal interaction between the buyer and supplier firm executives, reliability of supplier in terms of lead times, and quality of supplies.

The hypothesis describing the significant role of Information Technology (IT) in buyer supplier relations is represented by use of IT in product

design activities by the supplier, use of IT for communication and information sharing purposes by the supplier, use of IT for MRP/ERP purposes by the supplier.

The last two questions in the questionnaire relate to the hypotheses which speak about the supplier acting as informal source of market information, and the time gap between the recent products by the buyer.

4.2.2 Scale used for Study

Likert scale is used for extracting responses for the questionnaire. A scale ranging from very High to very low is used which ranks from 1-5 respectively.

4.2.3 Software used for Statistical analysis

SPSS (statistical package) is used to handle the data analysis part of the hypotheses testing of the questionnaires. Fishers exact [14] test is used to establish the significance of the relation between the variables.

CHAPTER 5

RESULTS AND DISCUSSION

Response to our questionnaire yielded information on various levels of supplier involvement at different stages of the new product development process in different situations. The data is basically divided into two parts, the first one describing the determinant variables i.e various situations in which vendor influences buyers' new product development process. The second part of the data examines the degree of vendor's involvement in the NPD process. This chapter analyses the data for key relationship based on the hypotheses of chapter 3.

5.1 DIFFERENT LEVELS OF SUPPLIER INVOLVEMENT

During the process of new product development, the level of involvement of suppliers appears to vary substantially across the different stages. To illustrate the fact, the frequency of responses for each stage plotted against the levels of the supplier involvement in fig 5.1. From the graph it is inferred that supplier involvement is predominantly seen in product development stage. Moderate level of involvement is seen in concept testing stage. The involvement of supplier is mostly low to very low in all other stages.

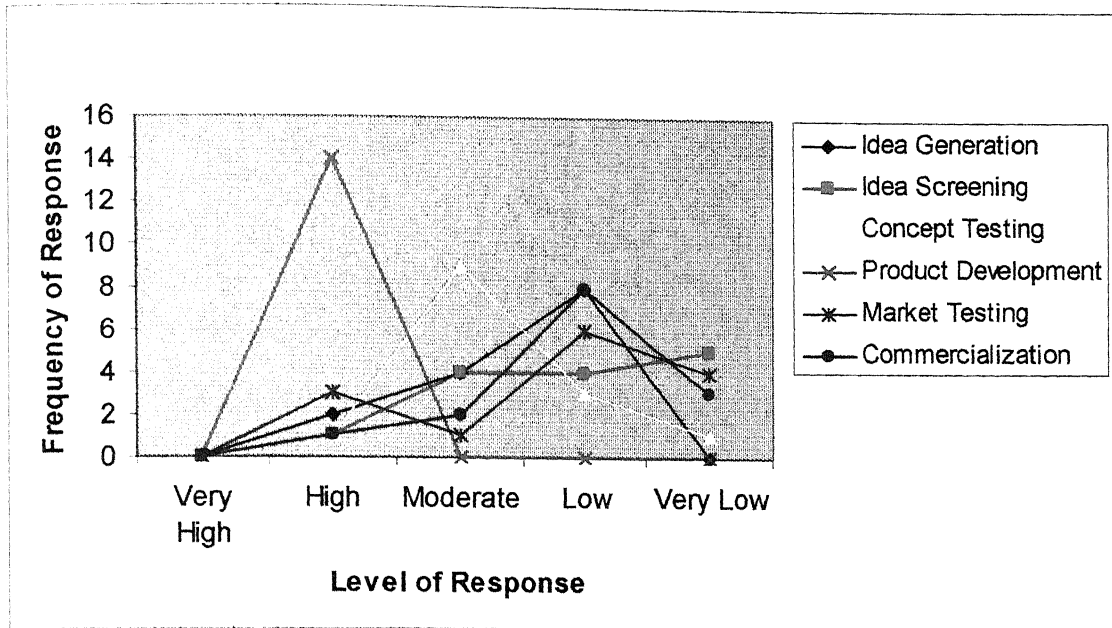


Exhibit 5.1 Different levels of supplier involvement at different stages

5.2 TESTING OF HYPOTHESES

For these tests, Fishers p- exact test is used, because the frequency of at least one cell is less than five in the contingency table. Each hypothesis has been tested for each of the five* contexts (stages of new product development). Significant results only are reported (in exhibit 5.3). For example, whether the effect of time pressure on supplier involvement during idea screening stage is significant at 90% confidence level is tested as below (in exhibit 5.2):

* The product development stage could not be tested in the above said manner as all the responses indicated a single response- high involvement of supplier.

| Time Pressure | Supplier Involvement (Idea Screening Stage) | |
|-------------------|---|-------------------|
| | Moderate to Low | High to Very High |
| Moderate to Low | 0 | 5 |
| High to Very High | 5 | 4 |

Exhibit 5.2 Contingency table for Time Pressure – Idea Screening

The result for the Fishers exact test is as follows:

The p-exact= 0.062937

As the p-exact value obtained is less than 0.1, the value is considered significant at 90% confidence level.

5.3 KEY DETERMINANT VARIABLES

Returning to exhibit 5.3, we find that the effect of many of the hypothesized determinant variables is not significant. Only the following emerge as the significant determinants of supplier involvement:

- *Time pressure*

This appears to affect involvement in idea screening and concept testing.

- *Being specialist supplier*

This appears to affect involvement during idea screening and market testing.

- *Reliability in terms of lead times*

This appears to affect involvement in both idea screening as well as market testing stages.

Exhibit 5.3 what affects the supplier involvement in the NPD process @ (Significant effects of determinant variables in various stages of the process)

Stage of New Product Development Process

| Determinant Variable | Idea Generation | Idea Screening | Concept testing | Market Testing | Commercialization |
|-----------------------------------|-----------------|----------------|-----------------|----------------|-------------------|
| 1.Complexity | | | | | |
| • level of Complexity | | | | | |
| • Sub Parts | | | | Significant * | |
| • Engineering intensity | | | | | |
| • Special Fields | | Significant* | | | |
| 2.Time Pressure | | Significant * | Significant * | | |
| 3.Cost Pressure | | | Significant * | | |
| 4.Specialist suppliers | | Significant * | | Significant * | |
| 5. Co-location of Supplier | | | | | |
| • Geographical Distance | | | | Significant * | |
| • Concentration of Suppliers | | | | | |

Contd.

| | | | | | | |
|--|----------------|---------------|----------------|--|-----------------|--|
| 6.Trust in Suppliers | | | | | | |
| • Length of relationships | | | | | | |
| • Informal interaction | | | | | Significant * | |
| • Reliability in lead times | | Significant * | | | Significant * * | |
| • Reliability in Quality Supplies | | | Significant * | | | |
| 7.Use of IT by Suppliers | | | | | | |
| • IT in Product Design | Significant ** | | | | | |
| • IT in Communication | | | | | | |
| • IT in MRP | | | | | | |
| 8.Informal source of Market Information | | | Significant ** | | | |
| 9.Time gap between new products | | | | | Significant * | |

@ The dependent variable has been tested on Kruskal Wallis test for all the stages. The test finds the data from different stages to be statistically independent. ** indicates 95% significance level; * indicates 90 % significance level (Based on Fishers exact test)

In addition, other determinant variables appear to effect supplier involvement as below:

- *More number of sub parts in the product*

This appears to affect involvement in market testing stage.

- *Requirement of special fields*

This appears to affect involvement in idea screening stage.

- *Cost pressure*

This appears to affect involvement in concept testing stage.

- *Geographical distance between the buyer and supplier firms*

This appears to affect involvement in market testing stage.

- *Extent of informal interaction between buyer and supplier firm executives*

This appears to affect involvement in market testing stage.

- *Reliability in quality of supplies*

This appears to affect involvement in concept testing stage.

- *Extent of IT use in product designs*

This appears to affect involvement in idea generation stage.

- *Supplier acting as informal source of market information*

This appears to affect involvement in concept testing stage.

- *Time gap between new products*

This appears to affect involvement in market testing stage.

5.3.1 Supplier influence in the Idea screening stage

Supplier influence in the idea screening stage is predominantly observed whenever there is a need for specialized fields in the product. In developing novel products, various special features must be introduced into the product. Suppliers with various specialists are involved in the idea

screening stage to discuss the feasibility of the idea generated. The product idea will only be finalized after consulting with all the specialized suppliers.

5.3.2 Supplier influence in the Concept testing stage

Supplier's influence is also observed in concept testing stage, whenever the time and cost pressures involved in product development are high. Suppliers who act as informal source of market information and who are reliable in terms of quality of supplies are also seen influencing the NPD process. The market reactions for the concept can be known early as the suppliers can provide market information.

5.3.3 Supplier influence in the Market testing stage

Supplier's influence is also observed in market testing stage when ever the geographical distance from the buyers is low, when the supplier is reliable in terms of lead times and when the informal interaction between buyers' and suppliers' executives is high. Specialist suppliers will be supplying to more number of firms thereby acquiring greater access to markets. To estimate the market mood and the target market size, these suppliers will be of great use.

5.4 SUPPLIER INFLUENCE IN THE COMMERCIALIZATION STAGE

Responses from the questionnaire do not support the hypothesis that some of the determinant variables mediate the influence of suppliers the commercialization stage of the new product development. After the product idea gets confirmed, and after the target market size is fixed, the

product will be launched into the market. Supplier will be providing the parts that will go into the final assembly of the products. Supplier involvement in this stage is inevitable. Regardless of the determinant variables chosen for the analysis of supplier involvement, the influence of the supplier on buyers' commercialization process is unavoidable.

5.5 SUPPLIER INFLUENCE IN THE IDEA GENERATION STAGE

Supplier involvement in idea generation stage can be seen only when the time and cost pressures in developing the products are high. The other variables which can explain the effect of supplier involvement in idea generation stage are time gap between the products and the informal source of market information. When the time gap between the products decreases or the market information from the supplier increases, the buyer may tend to involve the supplier in the NPD process. But our data did not support the above hypothesis. This can be explained in the following way.

Once a product idea is conceptualized, the determinant variables like complexity of a product trust in the suppliers, co-location of a supplier firm and use of IT facilities becomes relevant for explaining the influence of the supplier on the buyers' process. As the idea generation is a much earlier process than product conceptualization, the above said determinant variables cannot affect supplier involvement.

It is only observed that suppliers who use more IT facilities for product design activities tend to influence the buyer in new product development activities. This appears to be an incidental connection. Or, perhaps, organizations which are enlightened about the use of IT in product designs have also the attitude to involve suppliers in generating new product ideas.

CHAPTER 6

CONCLUSIONS AND LIMITATIONS

6.1 CONCLUSIONS

In the present thesis work, effect of eighteen determinant variables on supplier involvement at various stages of the new product development process is studied. The inferences obtained are represented in exhibit 6.1

From the results, it is observed that the *specialty of the suppliers* and the *requirement of special fields* in the new product developments are the two major determinant variables that are affecting the supplier involvement in idea screening stage. The idea screening stage is vital step to sort out the feasible new ideas from the infeasible ones. The product ideas where in the specialty of the suppliers must be included are to be sorted out with the help of the supplier intervention. By doing so the buyer firm can achieve the advantages of early supplier involvement.

Time pressure and *cost pressure* are the two variables that affect the supplier involvement in the new product development during concept testing stage. Once the product concept is fixed, it is to be brought before the target customers within minimum time. Simultaneous development of parts from the supplier end also starts. The other important factor that is to be kept in mind is the cost pressure. The costs involved in making changes in the model after getting feedback from the supplier regarding the final product specifications due to manufacturing limitations will be very high. These types of costs can be minimized by the timely

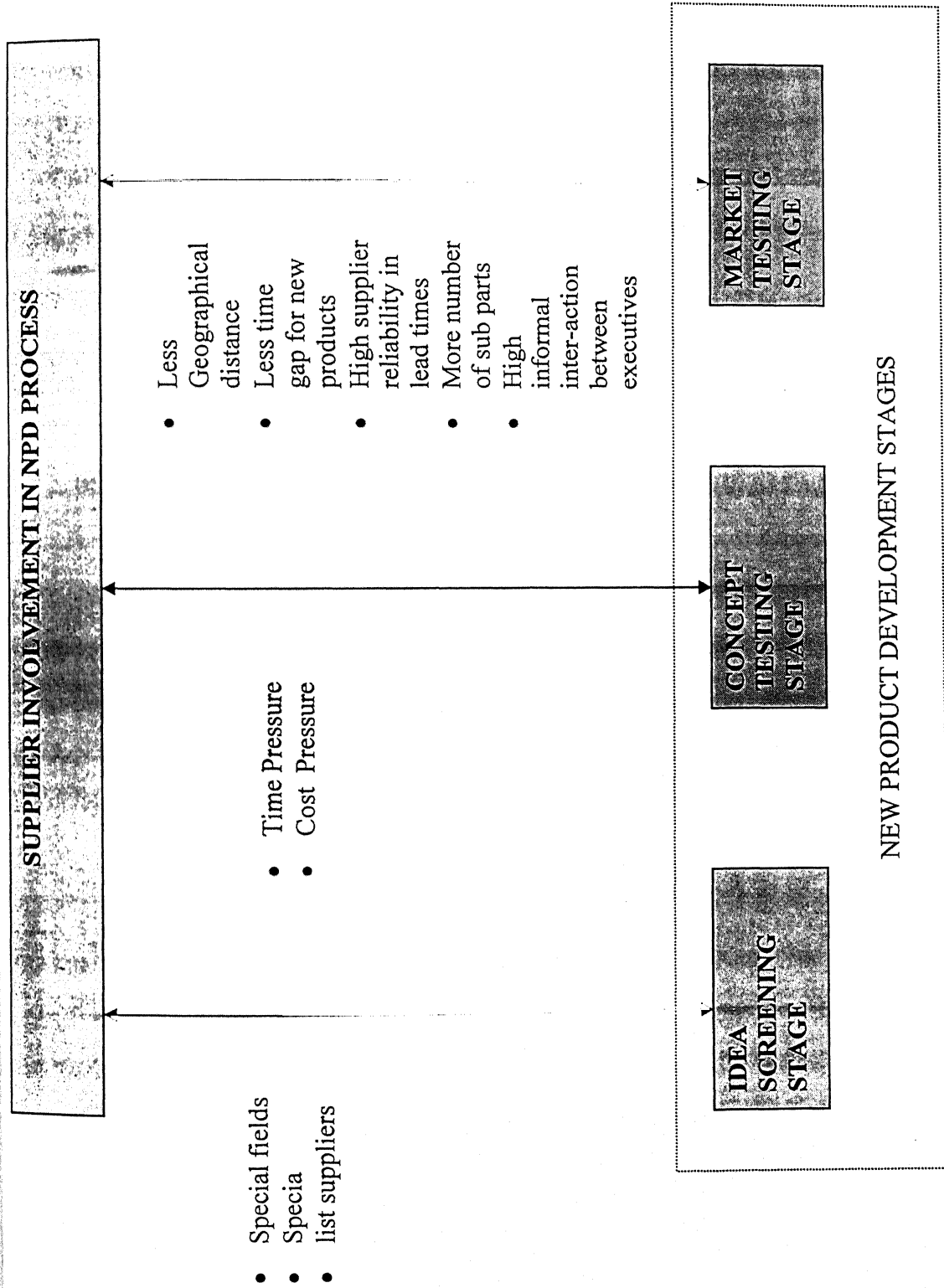


Exhibit 6.1 Effect of various determinant variables on the supplier involvement during NPD process

involvement of supplier in the early stages of product design. By this way cost pressures can be lessened.

The determinant variables that affect the supplier involvement during the market testing stage of the new product development are

- More number of sub parts in the product.
- Less geographical distance between the buyer and supplier firms.
- More informal interaction between the buyer and supplier executives.
- Less time gap between developments of new products
- High supplier reliability in terms of lead times

Market testing requires knowledge of market which is brought to bear on the testing process. If the vendor is nearby, or interacts informally with the buyer, or the product is complex, or the vendor is more reliable, then too the influence of vendor is more on the NPD process. Again if the firm frequently comes out with new products, the vendor is likely to have more experience with providing inputs into the product development that helps testing in the market.

6.2 LIMITATIONS OF THE PRESENT STUDY

Data available for testing the hypothesis has been the main limitation to this study. It is difficult to access the organizations. Because of this limitation, it is often difficult to test some of the proposed relationships. Another limitation of this study is that while the buyers' view has been obtained, it has not been possible to assess the view from the angle of the vendors.

REFERENCES

1. Shad Dowlatshahi A novel approach to product design and development in a concurrent engineering environment;, Technovation, 13(3) 1993; 161-176.
2. Jagadish. N. Seth , Arun Sharma, Supplier Relationships: A strategic initiative; Goizueta Business School Emory University, University of Miami
3. Robert G. Cooper and Elko J. Kleinschmidt ,An investigation into the New Product process: steps, deficiencies and impact;.
4. Philip Kotler, Marketing Mangement, 10th edition, September,2001, Prentice Hall of India, New Delhi.
5. Andrew Mair, Birkbeck New types of partnerships for Automotive Buyer-Supplier relations, School of Management and Organizational psychology, University of London.
6. Robert.B.Hanfield, Daniel. R. Krause, Thomas. V.Scannell, Robert.M.Monczka, Avoid the pitfalls in Supplier development, Sloan Management review, Winter 2000.
7. Jeffery. H.Dyer, How Chrysler created an American Keiretsu, Harvard Business Review,July-August,1996.
8. Christoph. H.Loch, Christian Terwiesch,Product development and concurrent Engineering, The Wharton school, University of Pennesylvania, working paper, 1998
9. M.Bensaou, Portfolios of Buyer- supplier relationships, Sloan Management Review, Summer 1999.
- 10.Rajan. R. Kamath, Jeffery. K. Liker, A second look at Japanese product development, Harvard Business Review, November-December 1994.

- 11.J.Y.F. Wijnstra and Rob H.A Van stekelenborg,The role of Purchasing in New Product development, results of a Dutch working group, Eindhoven University of technology, 1996.
- 12.www.ignoumeids.ac.in/ignou/erl/articles/Manu/5473.html
- 13.Charles Shepherd and Pervaiz K. Ahmed;NPD frameworks: a holistic examination European journal of innovation management, vol: 3, Number:3, 2000.
- 14.Fishers exact test- <http://home.clara.net/sisa/fisher.htm>

APPENDIX-A
STUDY ON PRODUCT DEVELOPMENT
(IIT KANPUR)

1. What is the amount of time you have spent in this department?
2. What are the New Products you have been involved with? Can you please describe them.

New product for this study is any one of the following:

- New products that create an entirely new market.
- New product that allows a company to enter an established market for the first time.
- New products that supplement a company's established product lines.
- New products that provide improved performance or greater perceived value by replacing existing products.(usually known as "New Model")
- Existing products that are targeted to new markets or market segments.
- New products that provide similar performance at lower cost.(usually known as "New Model")

Following questions attempt to assess various characteristics of the New Product Developments that you have been associated with.

Please take separate sheets for each new product and tick () as relevant.

Name of the Product: -----

1. What is the level of Complexity in this product? (For this study complexity in design refers to close tolerances, selection of new materials, criticality of product, complexity in manufacturing refers to precision product requirements)

☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

2. Number of sub systems in the Product lies in the range of

☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

3. Engineering Intensity* required in the Product. (* Engineering Intensity refers to the use of machinery, or use of sophisticated material handling systems to manufacture the product)

☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

4. Requirement of Specialized* fields in developing the product.

(* = Specialization may include use of special machines like CNC, special forming or fabrication methods like powder metallurgy, special surface treatment etc)

☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

5. Time pressure for developing the product.

☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

6. Cost pressure in developing the Product.

☐ Very High

☐ High

☐ Medium

☐ Low

☐ Very Low.

7 Extent to which the your firm required the involvement of specialists from suppliers in the development of this product.

☐ Very High

☐ High

☐ Medium

☐ Low

☐ None.

8. Geographical distance of the Key suppliers from your firm.

☐ Very Near

☐ Near

☐ Neither far nor near

☐ Far

☐ Very far.

9. Extent of concentration of Suppliers located in the same state or Geographical region

☐ Very High concentration

☐ High concentration

☐ Medium concentration

☐ Low concentration

☐ Very Low concentration.

10. Length (Period) of relation with key suppliers.

☐ Very Long standing

☐ Long standing

☐ Moderate

☐ Recent

☐ Very Recent

11. Extent of informal interaction with the supplier firm executives.

☐ Very High

☐ High

☐ Medium

☐ Low

☐ Very Low.

12. Proportion of suppliers who are Reliable in terms of lead times.

☐ Almost all

☐ High proportion

☐ Medium proportion

☐ Low proportion

☐ Almost None.

13. Proportion of suppliers who are reliable in terms of quality of supplies.

- ☐ Almost all ☐ High proportion ☐ Medium proportion
☐ Low proportion ☐ Almost None.

14. Proportion of Key suppliers who have IT facilities for product Design activities.

- ☐ Very High ☐ High ☐ Medium
☐ Low ☐ None

15. Proportion of Key suppliers who have IT facilities for information sharing and communications.

- ☐ Very High ☐ High ☐ Medium
☐ Low ☐ None.

16. Proportion of Key suppliers who use MRP/ ERP packages in house.

- ☐ Very High ☐ High ☐ Medium
☐ Low ☐ None

17. Extent to which suppliers act as informal source of Market information.

- ☐ Very High ☐ High ☐ Medium
☐ Low ☐ Very Low.

18. Time gap between last two recently developed products.

- ☐ Less than 3 Months ☐ 3 months- 1 Year ☐ 1-5 Years.
☐ 5-10 Years ☐ Over 10 Years.

Supplier involvement over the stages of product development

Product development stages

Supplier involvement was

| | |
|-------------------------------|--|
| Idea Generation | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |
| Idea Screening | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |
| Concept development & Testing | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |
| Product development | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |
| Market testing | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |
| Commercialization | <input type="checkbox"/> Very High <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low <input type="checkbox"/> Very Low. |

Company Name: _____

Respondent's Name: _____

Department: _____

Designation: _____

A 144417



A144417